ANALYSIS OF THE EC WEEE DIRECTIVE: CONSEQUENCES OF IMPLEMENTATION IN THE UK

A dissertation submitted to The University of Manchester for the degree of Master Science in the Faculty of Engineering and Physical Sciences

EKATERINA TSVETKOVA

ID 70796930

2007

SCHOOL OF EARTH, ATMOSPHERIC AND ENVIRONMENTAL SCIENCES
“This thesis is submitted in fulfillment of the Master of Science degree awarded as a result of successful completion of the Erasmus Mundus Masters course in Environmental Sciences, Policy and Management (MESPOM) jointly operated by the University of the Aegean, Central European University, Lund University and the University of Manchester”.
Table of Contents

CHAPTER ONE: INTRODUCTION.................................................................1
1.1. Background.................................................................................1
   1.1.1. Producer Responsibility in the Electrical and Electronic Industry.........2
   1.1.2. Development of the WEEE Directive............................................4
1.2. Aims of the Research...............................................................7
1.3. Research Methods and Scope.....................................................7
1.4. Research Structure.....................................................................8

CHAPTER TWO: THE PROBLEM OF ELECTRICAL AND
   ELECTRONIC WASTE – A REVIEW OF THE LITERATURE.....10
2.1. Introduction.............................................................................10
2.2. Pre-WEEE Official Reports......................................................11
   2.3.1. European Union-15 and Switzerland.........................................15
   2.3.2. International Practices (Asia, Americas and Australia).....................21
2.4. Dealing with WEEE – Other Relevant EU Legislation....................23

CHAPTER THREE: WEEE MANAGEMENT: THEORY AND PRACTICE........27
3.1. Introduction: Philosophy of WEEE Management..........................27
3.2. Design for Environment...........................................................28
3.3. Life cycle assessment (LCA).......................................................33
3.4. End-of-Life Equipment Management Practices

3.2.1. WEEE Recycling

3.2.2. WEEE Incineration

3.2.3. WEEE Landfilling

CHAPTER FOUR: TRANSPOSITION OF EC WEEE DIRECTIVE

OBLIGATIONS INTO THE UK LEGAL SYSTEM

4.1. Introduction

4.2. EC WEEE Directive – Overview

4.3. Positive Implications from the Implementation

4.4. UK Implementation of WEEE Directive

4.4.1. UK Governmental Response – DTI and Defra Approach

4.4.2. Risk Assessment

4.4.3. WEEE Directive Implementation Options

4.4.4. Costs and Benefits of Transposition of the WEEE Directive

4.4.5. New Mechanisms and Practices Implemented by the Directive

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion on the WEEE Directive

5.2. Further development of the WEEE Directive regime in the UK

5.3. Recommendations

BIBLIOGRAPHY
ABSTRACT

Technological and industrial progress introduced not only new mechanisms and materials; it also introduced new types of waste. Recent decades showed elevated concerns about the waste generation rates, particularly those from electrical and electronic equipment. Waste Watch estimated about 1 million tonnes of WEEE to be created by households and commercial groups in the UK annually\(^1\). The solution to this problem cannot be solely technological, but should also rely on integration of environmental factors into waste management culture: product design, policy design, and also the consumption patterns and attitudes of the consuming public.

Thus modern waste management strategies became more complex to be able to include “up-to-date” waste resources such as electric and electronic equipment waste; as well as to be able to reflect the behavioral changes in attitudes towards waste generation. Dealing with such scale of waste in an environmentally acceptable manner is a complex problem and an important social and economic issue. Governmental policies and industrial management practices should now combined to address elevated concerns of the society over the increasing waste quantities. This was recognized as early as 1993 in the Fifth Environmental Action Programme of the European Community\(^2\), in which a chapter was devoted to the problem of general waste management. There WEEE regulations were

\(^1\) WASTEWATCH 2000, Downloaded from \url{http://www.wastewatch.org.uk}, accessed on May 3, 2007.
first mentioned as one of the mechanisms of application of the principles of prevention, recovery and safe waste disposal.

The WEEE Directive will bring not only “direct environmental benefits” and benefits to human and animal health, but it will boost resource productivity and will lead to sustainable development of the country itself\(^3\). Being transposed into the UK domestic legislation the requirements of the WEEE Directive will become major mechanisms of dealing with electronic and electrical waste within the UK. The complexity of the nature of this waste, as well as a great number of the stakeholders involved, has provided rounds and rounds of consultations and negotiations with DTI, as well as other stakeholders and governmental officials. However, in the end of the day the Directive is now implemented and it is possible to see the first experiences and practices and work on further improvements of the WEEE treatment options.

DECLARATION

No portion of the work referred to in the dissertation has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

COPYRIGHT STATEMENT

The following three notes on copyright and the ownership of intellectual property rights:

i. Copyright in text of this dissertation rests with the author. Copies (by any process) either in full, or of extracts, may be made only in accordance with instructions given by the author. Details may be obtained from the appropriate Graduate Office. This page must form part of any such copies made. Further copies (by any process) of copies made in accordance with such instructions may not be made without the permission (in writing) of the author.

ii. The ownership of any intellectual property rights which may be described in this dissertation is vested in the University of Manchester, subject to any prior agreement to the contrary, and may not be made available for use by third parties without the written permission of the University, which will prescribe the terms and conditions of any such agreement.

iii. Further information on the conditions under which disclosures and exploitation may take place is available from the Head of the School of Earth, Atmospheric and Environmental Sciences.
ACKNOWLEDGMENTS

There are lots of people I would like to thank for being a part of my postgraduate education, as friends, teachers, and colleagues.

Firstly, I would like to thank my Supervisor, Mrs. Carolyn Abbot. I could not have imagined having a better advisor and mentor for my MSc, and I am so grateful to her for all common sense, knowledge, perceptiveness and support.

Also I would like to thank MESPOM Board for the award of the Erasmus Mundus Scholarship, which has supported me during my two years of studies. I would like to personally thank Mr. Ruben Mnatsakanian for his support at times of the Central European University, and Mr. Andy Gize from the University of Manchester. A special “thank-you” to Mr. Aleg Cherp, MESPOM Consortium Coordinator, who made these two years as safe and enjoyable as possible. My deep appreciation goes to Krisztina Szabados and Irina Herczeg for all their help in my life within and beyond studies.

Much respect to my MESPOmers and CEU classmates, and hopefully still friends, for putting up with me for almost two years and for being the surrogate family during my studies. Thanks to Olga, Ekaterina and Narina for continued moral support and understanding that kept my head above water. Particular “thank-you” goes to Nina for all her enthusiasm, devotion and a unique combination of a friend and a teacher.

I cannot end without thanking my Family, wherever they are, particularly to my Mum and Dad, Aunt and Uncle, on whose constant encouragement and love I have relied throughout my time at MESPOM. Most importantly to my Sisters, for everything.

Thank you ALL,

Ekaterina Tsvetkova

18th May 2007
CHAPTER ONE: INTRODUCTION

1.1. Background

Tonnes of waste materials are generated by different manufacturing industries and commercial organisations each year, in an attempt to meet rapidly growing needs of the consumer society. However, all consumables have a finite lifetime resulting in the landfilling of millions of tonnes of waste annually around the world, in Europe, and specifically in the UK\(^4\). Moreover, rapid technological advances in the field of electrical engineering, particularly in the area of information technology, are closely connected with high rate of throwaway of the obsolescence electronic goods and appliances\(^5\).

Last decades showed growing globally shared concerns that arise from the rate of waste generated from electrical and electronic equipment. Waste production rates are currently too high prompting a recent focus on sustainable management practices; in particular strategic waste management policies and planning; waste management technological improvement; modern waste management infrastructure; waste minimization, recycling and clean technology. The solution is not solely technological but relies on integration of environmental factors into waste management culture: product design, policy design, and also the consumption patterns and attitudes of the consuming public.


\(^5\) Waste from Electrical and ElectronicEquipment: A South Australian Perspective, University of South Australia, 2000.
Earlier waste management practices simply involved the separation of different waste materials e.g. metal, glass, plastic. Modern waste management strategies are far more complex and include additional waste resources such as electric and electronic equipment waste. However, the problem of waste is tackled now from the different perspective as well; governmental policies and industrial management practices are now combined with elevated concerns of the society over the increasing waste quantities.

1.1.1. Producer Responsibility in the Electrical and Electronic Industry

The electrical and electronic industry underwent rapid growth in the 20th century and continues to dominate the technical evolution in the new millennium. Products such as washing machines, colour televisions, mobile phones or personal computers have already become standard in average households while new technologies, such as flat screen televisions, flat speakers, digital videodisk players (DVD) or smart mobile phones are still arriving. The comfort and welfare of the everyday life in the developed world stimulates regular purchase of new products – replacing used items for more sophisticated and advanced apparatus.

However, the low cost of manufacturing and the quality and quantity of the products has grown to such extent that vast amounts of waste from electronic and electrical enters the waste stream annually in the European Union alone. According to DTI the volumes of electronic waste are increasing at an estimated rate of between 3% and 5% per annum.

---

This is partly due to high rate of technological change in the sector and the high rate of replacement of electrical and electronic goods. Older obsolete items become part of the increasing waste stream of the world or are shipped and sold to third world countries for second hand use.

In 1992, the Warren Spring Laboratory published a national survey for the UK, in which it was estimated that the amount of electric and electronic appliances sold in the near future should rise up to 100,000 tonnes each year\(^8\), which should correspond to about 3 million televisions, 1 million home computers, 5 million telephones and 2 million microwaves to be discarded every year in the UK\(^9\). In a similar assessment (5), Waste Watch estimated about 1 million tonnes of WEEE to be created by households and commercial groups in the UK annually\(^{10}\).

Dealing with such scale of waste in an environmentally acceptable manner is a complex problem and an important social and economic issue. This was recognized as early as 1993 in the Fifth Environmental Action Programme of the European Community\(^{11}\), in which a chapter was devoted to the problem of general waste management. Here, WEEE was mentioned as one of the areas to be regulated by the application of the principles of prevention, recovery and safe waste disposal.


A former Environment Commissioner of the European Union, Margot Wallström declared that, “due to the fast pace of technological innovation, electrical and electronic equipment constitute one of the fastest growing waste streams in the EU. It is therefore particularly important to implement the key principles of EU waste management policy, especially the prevention and recycling of waste, in this area.”\(^{12}\)

In February 2003, the Directive on Waste Electrical and Electronic Equipment (WEEE) was issued in the Official Journal of the European Union. This directive requires the establishment of separate collection and recycling systems for this new type of waste in all member states by 31 December 2006 at the latest.

1.1.2. Development of WEEE Directive

The principle of extended producer responsibility is incorporated in different pieces of European Union legislation, such as Packaging Directive or Directive on waste from end of life vehicles. WEEE Directive deals with producer responsibility for manufactured electronic and electrical appliances. The European Commission’s Directive on Waste Electrical and Electronic Equipment and its parent directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment were adopted on 13 February 2003.

Law-making in the EU is quite a time-consuming process where WEEE directive was not an exception. The Waste from Electrical and Electronic Equipment Directive has been in the making for several years.

The primary European Government entity responsible for drafting the directive is Directorate General XI (DG XI) Environment of the European Commission. According to Warva DG XI strived for reduction of waste from such electronic equipment as refrigerators, stoves, microwaves, vacuum cleaners, personal computers, printers, calculators, fax and answering machines, radios, luminaries, dialysis machines, smoke detectors, clocks, drills, saws and sewing machines\textsuperscript{13}.

While drafting the WEEE directive DG XI tried to achieve certain goals, such as preventing and minimizing electronic waste streams; proliferation of sustainable waste treatment practices – reuse and recycling; and decrease and minimization of risks and negative impacts on the environment, human and animal health, associated with recovery and disposal of electronic appliances. DG XI came up with two provisions\textsuperscript{14}. The first proposal prohibited the use of certain substances and materials, such as lead, mercury, halogens, and some others; the second was devoted to the extended producer responsibility. The financial burden of waste management activities as well as waste disposal is sought to be placed solely on the WEEE producer. This means that producers were expected to establish waste management facilities at their own cost and to be liable


\textsuperscript{14} Ibid.
for the collection of not only equipment they currently produce, but of the “historic waste” also.

The first draft of the WEEE directive was issued in early 1998. EU industry responded negatively. According to Warva, the industry claimed that the draft “failed to include previously solicited input on the science behind material ban and the appropriate responsibility for the management, collection, and recovery of WEEE”\textsuperscript{15}. A variety of stakeholder consultations, governmental negotiations and meetings with industry representatives were necessary to find a consensus of all the parties involved. A lot of technological and economical reasoning was behind this proposal.

Despite wide negotiation and consultation activities the second WEEE directive proposal which was drafted in July 1998 was again “met with great disapproval” by the representatives of the industry sector\textsuperscript{16}. Some researchers (Warva) even suggest that the second draft did not take into account industry’s input and in some cases digressed from the first. As expected, industry’s opposition to the draft increased. While never officially voicing opposition to the principle behind the directive, the electronics industry began to form coalitions within industry associations, such as ACEI and Eurobit/Ectel, to lobby their interests within the WEEE scope.

Third draft of the WEEE directive was enacted in July of 1999. General provisions of the draft directive imply “free take back” requirements and treatment obligations – manufacturers should ensure take-back and treatment of manufactured appliances. The


\textsuperscript{16} Ibid.
issue of the “historical waste” was acknowledged as a “political will of the legislators to make manufacturers and importers responsible for waste irrespective of the time the equipment was sold”\textsuperscript{17}. Material bans have subsequently been separated and included into proposed Directive on Restriction of Hazardous Substances. The European Commission adopted WEEE Directive in June 2000. It took the directive three years to be signed by the Parliament and Council; and up to six years to be implemented by the European Union Member States.

1.2. Aims of the Research

The present work’s overall aim is to assess and analyse the quality of the EC WEEE Directive provisions as a piece of legislation as well as its overall effectiveness and drawbacks, and analyse in particular the consequences of the introduction of this Directive in the UK. The research attempts to contribute to the understanding of transposition and implementation of the Directive into the UK domestic legislation; as well as to highlight the policies that encourage the development of more environmentally adapted products and product systems in the UK. Moreover, implementation costs in addition to positive implications will be also evaluated together with the implementation options and compliance problems.

1.3. Research Methods and Scope

The major research method for this paper is a review and assessment of the relevant literature, as well as official governmental reports and pieces of legislation. This method

is acknowledged to be “well-recognised and valid. In order to review the state of knowledge, due cognisance should be given to the quality of sources”\textsuperscript{18}. Within this research such sources as peer-reviewed international journals and scholarly publications were used. Governmental guidance notes, as well as mandatory and advisory studies and surveys of the special governmental bodies (such as DTI and Defra) have been fully examined together with relevant EC and international valid documentation. Likewise, other secondary sources and reviews of the relatively connected literature on frontier areas as producer responsibility and waste management in general. Official internet resources and on-line journals and databases were also used as a part of the research.

The scope of the research is limited to the UK implementation of the WEEE Directive, however for the purposes of achieving an overall picture the analysis of the international legislation and policy instruments, as well as management practices was undertaken. The major emphasis is made on the effects from the legislative introduction of the WEEE waste management practices into the UK.

1.4 Research Structure

The following research consists of the five chapters.

- Chapter one is an introductory chapter that combines background information on the research topic and describes methods, scope and purposes of the research.

• Chapter two presents a review of the relevant literature, together with national and international regulations and pre-WEEE management practices.

• Chapter three shows the theory and practice of the WEEE management. Philosophy of the WEEE management and design for environment describes the theoretical part of the chapter, while the UK WEEE management (recycling, incineration and landfilling) reflects current practices.

• Chapter four analyses the transposition of the EC WEEE Directive into the UK legal system. In this part of the research the provisions of the EC WEEE Directive are analysed together with the implementation options chosen for the UK. Governmental responses to the implementation are discussed and referenced. Risk assessment, costs and positive implications of the transposition are highlighted.

• Chapter five is a concluding part of the research. It is logically divided into two main areas – conclusions with regards to the WEEE Directive per se, and those devoted to the incorporation and further transposition of the Directive into the UK domestic legislation.
CHAPTER TWO: THE PROBLEM OF ELECTRICAL AND ELECTRONIC WASTE – A REVIEW OF THE LITERATURE

2.1. Introduction

During the last two decades, European countries constantly faced a severe shortage of landfill sites. That situation fuelled the implementation of the regulations aimed at dealing with the amounts of waste streams, especially recycling and reuse. Electronic waste together with packaging waste, cars and batteries was identified as one of the major sources of waste. However such particular component of the generic waste stream as WEEE was claimed to be “easily diverted to alternative processes other than landfill” when relevant legislation would be in place.

Appearance of the concerns over the electronic and electrical waste can be traced back to the studies related to sustainable development. Achieving sustainability for the next generation as well as the present requires intensive changes in political structures, business performance, accepted social ethics and environmental education systems, as well as many other areas. This chapter reviews recent management practices and pieces of legislation as reflected in different literature sources.

---


2.2. Pre-WEEE Directive Official Reports

The studies before the initial WEEE Directive enactment represent works conducted by or for government agencies, research institutions, universities and specialist consultants. Thus, Ministry of the Environment of New Zealand conducted a thorough research devoted to the Literature review on the Environmental and Health Impacts of Waste Electrical and Electronic Equipment\(^\text{22}\). This report recites and assesses official publications from Nordic Council of Ministers. Some of the main findings of this literature review are presented further in this paper. One of the first reports to be mentioned is a research paper by the Swedish Environmental Protection Agency (SEPA) - Electronic and Electrical Equipment: The Basis for Producer Responsibility (1995) that made several observations and conclusions in relation to WEEE. The report was one of the first to acknowledge the significance of the impacts of any electronic and electrical appliances throughout their whole life cycle “from cradle to grave”. The idea of WEEE recycling was supported, as well as the problems of WEEE landfilling (waste leachate, lack of information about metals interaction, general level of scientific uncertainty in relation to WEEE landfilling) were acknowledged. Therefore SEPA suggested dismantling and secure disposal of components containing hazardous substances. According to the Literature review study SEPA report “proposed general principles for the WEEE policies, such as stringent requirements for disposal sites, increase in

environmentally friendly recycling practices as well as an overall fundamental aim to recycle metals to the greatest possible extent.\textsuperscript{23}

In the year 1995 Nordic Council of Ministers conducted two surveys: “Waste from Electrical and Electronic Products – a survey of contents of materials and hazardous substances in electrical and electronic products\textsuperscript{24} and “Environmental Consequences of Incineration and Landfilling of Waste from Electronic Equipment\textsuperscript{25}. The former report reflects the emerging concerns about the treatment of CRTs (cathode ray tubes) as a lead-containing component. The problem becomes urgent as volumes of CRT production increase. The latter survey “Environmental Consequences of Incineration and Landfilling of Waste from Electronic Equipment” focuses on the impacts from electrical and electronic equipment. This report places attention on the uncertainly of the processes that take place inside the landfill. Especially in case of organic waste it seems to be close to impossible to estimate the consequences of the interactions between the landfilled components, their levels of toxicity and emissions. However it is emphasized that high level of uncertainty should not be the reason for negligence.

One of the most important documents “directly influencing the need for increased policy and legislative attention to WEEE impacts” is the European Commission's Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and


Electronic Equipment\textsuperscript{26}. The Proposal describes, analyses and gives evaluation to the EU WEEE and RoHS Directives; offering information about emerging WEEE concerns and impacts. “\textit{Increased recycling of electrical and electronic equipment, in accordance with the requirements of the proposal for a WEEE Directive, will limit the total quantity of waste going to final disposal. Producers will be responsible for taking back and recycling electrical and electronic equipment. This will provide incentives to design electrical and electronic equipment in an environmentally more efficient way, which takes waste management aspects fully into account. Consumers will be able to return their equipment free of charge.}”\textsuperscript{27}

The proposal to the directive states that landfilling is the main type of WEEE treatment; to add to this the fact that 90 per cent of this equipment is being disposed of without any separation or other pre-treatment. The result is high levels of hazardous substances emissions into the environment. The most common case is when small appliances are co-disposed with other types of waste.

Electronic and electrical waste contains lots of different materials and components, which can behave differently when landfilled or incinerated. As already been mentioned the level of scientific uncertainty about the interactions of substances contained in discarded equipment stays reasonable high. The main areas of concern are leaching (as a result of


leachate runoff and groundwater contamination) and evaporation of such components. Landfill Directive\textsuperscript{28} sets standards for leachate treatment and collection, however these best practices do not solve the problem of WEEE disposal as is mentioned in the Proposal to the WEEE Directive. In cases where high standards for leachate collection are applied, collected leachate is treated and further processed. However even at this stage it might be already too late as components from electrical and electronic equipment reacted with municipal sewage waste. Unfortunately not every landfill site applies these standards as well as best available techniques in relation to waste treatment. At the end of the day these uncontrolled waste collection facilities will be replaced or upgraded to high standards set by the Landfill Directive. Until then, uncontrolled contaminated wastewater runoff will contaminate soil, surface and groundwater streams.

The Proposal emphasizes the fact that while landfilling WEEE instead of reusing and recycling current generation contributes to the resources depletion as well as overall environmental contamination and degradation. It is impossible to give exact figures of the materials that can be recovered from the discarded electrical and electronic appliances and brought back to industry, mean values should vary from country to country and throughout the time span, however the general impact on the environment is well known and documented.

2.3. National and International regulations and practices before EC WEEE Directive

This section provides a review of the various legislations and initiatives of the EU-15 Member States and Switzerland, as well as gives some idea about Asian and American management approaches regarding WEEE and principle of the extended producer responsibility.

2.3.1. European Union-15 Member States and Switzerland

The history of regulations regarding manufactured final products began with the European Governments requirement to takeback and recycle used packaging material. These takeback requirements have been extended to End-of-Life Vehicles and recently to Electrical and Electronic Equipment as well. EU Member States can be divided into two groups – those countries that used to have domestic WEEE managing systems and those, which only introduced such systems with the implementation of the Directive. Countries, such as Austria, Belgium, Denmark, the Netherlands and Sweden, have already had similar domestic regulations and that is why were the first Member states to present their national WEEE legislations. Finland, Germany and the UK joined later. Portugal has as well delayed the implementation of the electronics take-back legislation. An overview of these management strategies will be given in the following sections. The information presented in the subsequent sections was taken from the governmental reports, institutional studies, industrial surveys, as well as scholar researches.
**Austria**

Austria was among the first in Europe to implement take-back and recovery legislation on lamps and on white goods in 1992 and 1993\(^{29}\). According to regulations, a deposit was charged to consumers during the sale, which was later returned at the take-back stage. In 1997, the Austrian Normalisation Institute proposed a regulation for the processing of electronic scrap, covering computers, office equipment, TVs, VCRs and other products. The recovery system is financed through take-back responsibility, which is on the retailers who are obliged to take-back old equipment or pay back the deposit.

**Belgium**

In 1999 Belgium has adopted regulations on white and brown goods emphasizing separate collection for usable and unusable equipment together with disposal ban on electronic equipment without any previous treatment. Targets for the recycling of plastics, ferrous and nonferrous metals are also included. The actual take-back system is based on a “new for old” scheme in the shops or at the delivery stage. Then, products are returned to the producers and importers who ensure the treatment at their own expense\(^{30}\). Producers, retailers and importers are obliged to prepare separate reports on takeback, treatment and disposal of WEEE.

**Denmark**

Ordinance for treatment of waste electrical and electronic equipment was proposed in Denmark in 1997, demanding separate collection and treatment of all kinds of electrical

---


\(^{30}\) Ibid.
and electronic equipment\textsuperscript{31}. Local authorities are in the position of setting up collection systems for WEEE with the priority of collection from the retailers. In addition, some private companies can hand over their appliances to the recyclers at their own cost. All the above-mentioned operations should be notified to the Danish Environmental Protection Agency. The Danish government then finances (from the municipal waste removal fees) the local authorities, which in turn prepare a report on their performance\textsuperscript{32}.

\textit{Finland}

In Finland, the producer responsibility legislation for WEEE suggests that a fee for collection and recovery should be included in the price of a new product. However, the legislation has been delayed due to ongoing pilot collection and recovery studies run by the government. Depending on the results of these studies, national legislation would be introduced.

\textit{France}

In France shared responsibility is the preferred idea for managing WEEE, although no legislation has been drafted so far. Presumably, the government would favour the reverse logistics scheme (using the same transport for delivery of new goods and uplift of collected items) run by the industry\textsuperscript{33}.

\textit{Germany}

The “Dual system in Germany” was funded in 1990, which is manufacturers’ non-profit organisation for recovering and recycling packaging. Companies joining this system have

\textsuperscript{32} Fezsty, K., ”An economic appraisal of collection systems for waste electrical and electronic equipment (WEEE)”, Thesis (Ph.D.), Glasgow Caledonian University, May 2003.
\textsuperscript{33} Ibid.
to pay fees and in turn their products may carry a green dot symbol on the packaging. Computer manufacturers are responsible for the take-back and recycling of packaging material of their goods. The “Blue Angel”, first collection system, was implemented in 1996. Recyclers and manufacturers have put forward a voluntary initiative to pre-empt the implementing of CYCLE a (recycling) bill through which the government will be able to regulate any waste stream. In addition, there is voluntary take-back legislation for large household appliances and brown goods. The draft ordinance is in preparation for the take-back and disposal of office, information and communication equipment. The last owner is obliged to bring back the old appliance, which is collected by waste management companies. Finally, producers are liable for collecting items for recycling and for the costs of recycling. As a feedback for the waste authorities, it would be a requirement to report on the WEEE collected by producers and importers\textsuperscript{34}. This new take-back philosophy would affect everyone selling to the German market.

\textit{Italy}

The collection and recovery of some domestic appliances was presented in Italy in 1997, which was later extended to such electronic products, as TVs and computers. The take-back is free of charge for the end-user if a new product is purchased. By national decree in Italy, manufacturers are required to develop a take-back scheme or a 10\% government tax will be introduced on these items\textsuperscript{35}.


The Netherlands

In the Netherlands, a decree for the removal of white and brown goods came into force in 1999 (was first drafted in 1997), which covers the take-back requirements for electronic and electrical equipment. The regulation was introduced in two phases to help to eliminate problems and facilitate the development of a collection and recycling system. The first phase concerned large items while the second one the smaller ones. The take-back at the delivery stage is the responsibility of retailers, who are required to take-back products free of charge when delivering a new one. In the case of discarding goods from the households, the local authorities would be responsible for the products. Producers and importers are obliged to take-back products collected by the retailers and local authorities irrespective of the brand. They are also obliged to provide a description of recycling and disposal of the collected electronic products to the environmental ministry. The decree also introduces a ban on incineration and landfilling of separately collected items. It permits the industry to impose a surcharge on new products to help finance the take-back scheme and chain deficit. Quantitative objective set up by the decree can be described “as much as possible”36. Finally, local authorities will have to set up collection hubs for electrical and electronic equipment. In reaction to this law, manufacturers and importers created an association for the Disposal of “Metalectre” products (NVMP) to ensure that the end-of-life items collected are processed in an environmentally conscious manner. They collect an advance disposal fee at the time of purchase.

**Norway**

The producers’ responsibility scheme in Norway was adopted in 1998, and it allows a surcharge on new products to fund their collection later. Retailers and municipalities are obliged to accept WEEE returned by consumers. The delivery of the items to the local collection points is free of charge and is set up through producers and importers who are responsible for regional collection, transport and treatment. Norway’s target is to collect 80% of all electrical and electronic waste within the first 5-year period\(^{37}\). Norway is currently taking enforcement action against domestic companies that are not joining a collection scheme and importers must pay their fees through customs. The fee covers collection, transport and recycling.

**Sweden**

In Sweden, the final ban on landfilling of electronics was enforced in 1998, which means that producers take responsibility for the WEEE, excluding freezers and refrigerators, since there is a municipal responsibility for these items. Manufacturers and municipalities are sharing the costs of collection and dismantling EEE, and in addition they are also responsible for the development of a take-back scheme for it. Equipment is collected from consumers free of charge, which means that manufacturers pay fee for collection, transport and recycling.

**Switzerland**

In Switzerland, the ordinance on WEEE was introduced in 1998, involving a take-back system for consumer electronics, household appliances, office and IT equipment\(^ {38} \). It


supports the take-back and disposal schemes and establishes requirements for the export of WEEE to disposal. Manufacturers must take-back their own products, so consumers can bring end-of-life appliances to any retailers free of charge, who send them back to the manufacturers/importers for disposal. For all export, recycling, treatment and disposal activities permission is required, which contains details of these actions. The financing of the collection and treatment schemes is covered by remains on the industry, which would be a surcharge on the new products. SWICO is a voluntary organisation made up from manufacturers providing the primary system for collection and recycling of WEEE in Switzerland.

2.3.2. International Practices (Asia, Americas and Australia)

Asia

Activities regarding WEEE are in place in Asia too. For example, in Singapore, a simple voluntary take-back system exists on the manufacturers’ initiative. Similarly, in China, take-back initiatives originate from the private sector, which is dominated by Japanese manufacturers located in China. A take-back mandate was launched in Taiwan in 1998 similar to one in Japan. Manufacturers and retailers are responsible for establishing take-back and treatment systems. The recycling fund is created, supported by the profits from selling, which is managed by the local government. The recycling fee is paid by the manufacturers and based on their sales figures. The introduced voluntary sticker system allows labeling of participating products. South Korea also established a manufacturer’s

---

responsibility for products, such as refrigerators, washing machines, air conditioners, TVs and computers.

**Australia**

In Australia and New Zealand, there is no apparent intention to introduce national legislation on WEEE, although cell phones are systematically collected in Australia\(^39\).

**America**

Several take-back activities appeared in America, from which just a few are government initiatives, while others are driven by the industry. The Brazilian government circulated a waste regulation, including some special instructions for the WEEE as well. The Canadian government and the U.S. federal government have been very active in this area of interest. Electronics recovery immediately at the collection and recycling levels plays a big role in the USA\(^40\). In fact, the Extended Producer Responsibility is a partnership between businesses and local governments. Some states introduced a landfill disposal ban on white goods and Cathode Ray Tubes (CRT). Alternatively, few pilot projects have been conducted primarily on the initiation of the industry. In Minnesota, in Texas and in Massachusetts, etc. communities developing electronics collection programs are strongly supported. These include drop-off sites and seasonal kerbside collections along with electronics recycling. In Canada, the province of Ontario proposed provincial legislation requiring manufacturers to pay 50% of the blue box operating cost as well as to develop funds and implement diversion programmes for WEEE and other packaging materials.


The rest of the blue box fee is paid by the government and consumers and the fee is collected by Waste Diversion Ontario.

2.4. Dealing with WEEE – Other Relevant EU Legislation

Besides the WEEE Directive, there are other pieces of legislation that are not bound by but are relevant to treatment, recovery and recycling of electronic and electrical waste. They are described in the subsequent sections of this paper.

**Directive 2006/12/EC on Waste (the Waste Framework Directive or WFD)**

The WFD lays down controls for the safe disposal and recovery of waste. In particular, according to Article 3 of the directive Member states should take appropriate measures to ensure prevention or reduction of waste production and its harmful effects by development of clean technologies, improved product eco-friendly design and focus of final disposal techniques. The recovery of waste should take place by means of recycling, reuse and reclamation. Article 4 demands waste to be recovered or disposed of without endangering human health and without using processes or methods that could harm the environment. Articles 9 and 10 of the WFD require any establishment of waste recovery or disposal activity to obtain a permit from the competent authority unless an exemption from permitting is allowed by Article 11. According to Defra Report[^41] “The WEEE Licensing Regulations transpose the permitting and treatment requirements of the WEEE Directive by amending the Waste Management Licensing Regulations 1994 to provide for

operators who accept WEEE for treatment to comply with the standards laid down in the Directive”.


According to the WEEE Directive in case WEEE or its components constitutes hazardous waste it becomes subject to the requirements of hazardous waste legislation as well. The Hazardous Waste Directive demands hazardous waste to be tracked from the point of production to the final point of disposal or recovery with all relevant documentation records. In case of mixed waste (hazardous and non-hazardous), separation is a necessary requirement. “WEEE and Hazardous Waste” survey, Parts 1 and 2, identifies the classification of hazardous WEEE items according to the Hazardous Waste Directive.

**Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment** (the RoHS Directive)

According to the RoHS Directive lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs) must be replaced in electrical and electronic equipment by other substances (Article 4). According to DTI producers must be able to demonstrate their compliance with the given regulation by submitting technical documentation or other information to the enforcement

---


43 In the UK was implemented as The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2005.

authority on request and retain such documentation for a period of four years after the EEE is placed on the market.

However, as it is not always scientifically possible to completely prohibit the substances in question at present level of technological progress, and thus Amendments to the RoHS Directive provide exemptions for certain levels of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs) in electrical and electronic appliances. Exemption for presence of hexavalent chromium is granted so far until 1 July 2007.

Among others, the ODS and PPC Regulations have some implications in relation to electronic and electrical waste. Thus, ODS Regulation provides recovery and destruction requirements for ozone depleting substances contained in refrigeration equipment. Some electrical equipment, e.g. freezers, contain ODS and thus are subject to ODS regulation requirements. The PPC Regulations\textsuperscript{45}, which transposed the IPPC Directive\textsuperscript{46} into the UK national legal system, apply an integrated approach to the regulation of certain industrial activities including those concerned with waste disposal.

Council Regulation (EEC) No 259/93 on the Supervision and Control of Shipments of Waste within, into and out of the European Community (the Waste Shipment Regulation)

The Waste Shipment Regulation deals all shipments of waste in the European Community. Under the Article 16 (Chapter B) of the regulation, all exports of hazardous waste to non-OECD countries are prohibited. All transfrontier WEEE shipments fall under the Waste Shipment Regulation\(^47\) as well. Shipments of WEEE for recovery (Chapter B) are permitted to non-OECD countries provided that waste is non-hazardous and this is in line with the Waste Shipment Regulation, Commission Regulation (EC) No 1547/1999 (as amended) and Council Regulation (EC) No 1420 (as amended) (the Green List Regulations) and they do not fall within the export ban.\(^48\)


CHAPTER THREE: WEEE MANAGEMENT: THEORY AND PRACTICE

3.1. Introduction: Philosophy of WEEE Management

Up until the late 1980s, the common approach to tackle environmental problems consisted of monitoring the pollution arising from the waste after it has actually been produced\(^49\). Since then, however, government agencies and ministries have recognized the need for shifting the attention from these “end of pipe” solutions towards developing “greener products”, such as more energy efficient ones or those capable of avoiding the production of potentially toxic materials. Although these philosophies are not fully implemented in practice and incorporated in the legal requirements, it is quite common nowadays for companies and industries to incorporate environmentally friendly solutions into the design phase of their new products and services.

At first these innovative approaches simply were intended to draw more attention to the product development phase, but recently they started assisting in producing an entirely new generation of products at the beginning of the design and manufacturing phases, instead of the “end-of-pipe” waste stage. Thus, the creation of excessive amounts of waste can be avoided at the design stage. It is often suggested, that innovative design strategies can best address life cycle environmental impacts while maximizing functionality\(^50\).

A number of new tools and approaches have emerged, guiding design and innovation towards low waste and eco-efficient products. At the beginning of the 1990’s,

---


\(^{50}\) Ibid.
developments of new disciplines appeared in the design. Products began to be created not only for function but also for easy assembly and disassembly. A review of the main philosophical, legislative and technological approaches for dealing with electrical and electronic waste will be presented in the following sections.

3.2. Design for environment

Design for Environment (also known as Ecodesign) can be broadly defined as a systematic approach to design, incorporating environmental, health and safety concerns over the full life cycle of the product. Moreover, design for environment “implies that there is a need to balance ecological and economic requirements while developing products. Ecodesign considers environmental aspects at all stages of the product development process, striving for products, which make the lowest possible environmental impact throughout the product life cycle. In the end, ecodesign should lead to more sustainable production and consumption”51.

The aim of this methodology is to reduce the adverse impact of manufactured products on the environment throughout product’s entire life cycle. The raw material’s acquisition, the manufacturing, distribution, use, as well as the reuse, recycling and final disposal are all taken into account in this concept. The ability to incorporate environmental concerns into the product development process is becoming increasingly important as diverse constituents make greater demands upon firms for improved environmental

51 Brezet, J.C., and van Hemel, C., Ecodesign: A promising approach to sustainable production and consumption (Paris: UNEP, 1997)
performance. That is why the WEEE Directive specifically encourages ecodesign of all electrical and electronic equipment (see Article 4 of the Directive). To add to this the fact that Secretary of State is allowed to “take appropriate measures so that producers do not prevent, through specific design features or manufacturing processes”, reuse, recycling and treatment of WEEE.

Ecodesign, as a new approach to product development, is an especially popular adopted tool in the electrical and electronic equipment manufacturing industry. Many multinational companies have adopted the aim to improve “eco-efficiency” by manufacturing new and improved products with less environmental impact over their life cycle. Adoption of green design not only contributes to the long-term profitability, but also helps to avoid future regulatory problems.

Ecodesign involves the combination of the following strategies for environmental impact minimization over the whole life cycle of the product:

- Using cleaner, less wasteful and less polluting techniques for manufacturing;
- Selecting low impact renewable and recyclable materials;
- Reducing the environmental impact from the use and maintenance of products (e.g. energy consumption);
- Optimising product life (e.g. creating durable, classic designs);

---

Reducing the environmental impact from the packaging and distribution of the products;

Reducing the weight or volume of materials in the product; and

Extending reuse by promoting remanufacturing and recycling and by reducing the disposal at the end of product life.

Nowadays design for environment became a widely accepted concept, which includes such disciplines as design for assembly, design for manufacturing, and design for disassembly. These “design for” practices have recently become industrial “buzz words” for are commonly termed as “Design for X”.

**Design for Disassembly, Reuse and Recycling**

It is believed that no more than 20 per cent of costs and benefits can be influenced by the disassembly or recycling processes\(^56\), the rest depends on the product design. Design for Disassembly, reuse and recycling means that the product is designed in such a way that the end of life disassembly, reuse and recycling could be achieved with minimum cost and effort. It is an industry that is interested in developing methods and tools for incorporating environmental considerations into product design\(^57\).

The basic guidelines for designing a new product according to the DfD approach are\(^58\):


1. Reducing total material content as well as total number of components;
2. Maximising the use of recyclable materials;
3. Minimising the total number of different materials used;
4. Avoiding composite materials or bonding of different materials;
5. Ensuring that all materials are labeled;

- **Design for Refurbishment and Remanufacturing**

Design for Refurbishment and Remanufacturing is characterized as a strategy likely to be far more cost-effective than a simple design for disassembly for recycling materials\(^{59}\). The basic characteristics for this are: durability (1), upgradeability (2), repairability (3), and recycleability (4)\(^{60}\).

1. **Durability**

Focusing on the durability or extension of product life is a strategy, which may lead to waste prevention in electrical and electronic production. Durability is a design objective by which longer period of product function, efficiency and nature of use are expected. Cooper\(^{61},^{62}\) advocated the design of products, which last longer, suggesting that long-life products mean less energy consumption and better material efficiency while the rapidly developing technology can offer more resource efficient products. He also concluded that although product durability and recycleability have increased, there is little evidence that products last longer because the replacement by newer items continues to dominate.

Therefore, new developments should integrate both durability and recycleability in a new

---

\(^{59}\) Fezsty, K., *"An economic appraisal of collection systems for waste electrical and electronic equipment (WEEE)"*, Thesis (Ph.D.), Glasgow Caledonian University, May 2003.

\(^{60}\) Ibid.


product. Despite this, recycleability appears to be popular approach between manufacturers (such as Philips, Braun, Miele) used as an “environmental excuse for instant obsolescence”\(^{63}\).

2. **Upgradeability**

Upgradeability is an ability of the product to be upgraded and updated with improved components by which it can remain in use longer without losing level of its operational performance. This approach is popular mainly among office equipment manufacturers (for example Hewlett-Packard), which use this method to achieve built-in “futurability”.

3. **Repairability**

This is another factor beside the abovementioned durability and upgradeability towards achieving a longer product life. There are several reasons why electronic and electrical appliances become less repairable nowadays than in the past\(^{64}\). Low material cost, changes in manufacturing and assembly methods, low price of imported goods all contribute to this effect. From the material point of view, using fewer pieces glued, clipped or welded together makes manufacturing cheaper and takes shorter time to assemble. On the other hand, the gained compactness makes disassembly and repair more time consuming and economically unviable.

4. **Recycleability**

Recycleability at the present stands only in a strict technical sense but in reality it represents rather a potential or possibility for recovery and reprocessing at the end of


useful life\textsuperscript{65}. Many manufacturers claim their products are recyclable, but few of them actually offer an infrastructure necessary for the recovery and processing of these items. Companies, such as Bosch and Scottish Power, nowadays take back products with no charge and dispose of them with responsibility and know-how.

Lewis and Gertsakis\textsuperscript{66} showed that designing for durability, serviceability, upgradeability or recycleability can have similar technical requirements and that permitting those characteristics within one single design could yield a longer product life. This means that durability is not contrary to recyclability, so a product can be easily disassembled to perform the repair and also upgraded to ensure that no cross material contamination occurs at the product’s end of life. Recycling and reuse must be designed in a cost-effective manner so that the cost of recycled materials does not exceed the cost of virgin materials.

3.3 Life cycle assessment

Life cycle thinking is a way of addressing environmental issues and opportunities from a system or holistic perspective and evaluating a product or service system with the goal of reducing potential environmental impacts over its entire life cycle\textsuperscript{67}. More specifically, life cycle assessment (LCA) involves an inventory of the environmental burdens associated with a product (processes or activities) by identifying and quantifying material


\textsuperscript{66} Lewis, H., Gertsakis, J., Design + environment: a global guide to designing greener goods (Sheffield: Greenleaf, 2001).

use, energy use, emission, or waste release into the environment in each life cycle stage\textsuperscript{68}. The intention is to develop an overall picture of the environmental impacts associated with a product in each stage of the life cycle. Thus LCA can be envisaged as a tool to assess or calculate the extent to which a product is environmentally-friendly.

Additionally, a tool known as WISARD\textsuperscript{69} (Waste Integrated Systems Assessment for Recovery and Disposal) was developed by the UK Environment Agency for quantifying emissions and environmental impacts from waste management. WISARD also applies life cycle assessment techniques for waste management in general and calculates greenhouse gas emissions, air pollution and energy consumption (non renewable energy resources). However, it can only quantify those potential environmental impacts, which can be readily quantifiable and cannot assess biodiversity, soil diversity, soil quality, visual amenity and natural and cultural heritage inputs.

3.4. End-of-Life Equipment Management Practices

3.4.1. WEEE Recycling

Recycling of the end of life equipment consists usually of the following steps. The initial phase is the collection of WEEE, followed by the evaluation for potential reuse and resale/donation or, if economic return is not high enough, for viable refurbishment. This means that the potential resale value reimburses the cost of upgrading\textsuperscript{70}. If this is as well

\textsuperscript{68} Vigon, B.W., \textit{Life-Cycle Assessment: Inventory Guideline and Principles} (CRC Press Science, 1994).
\textsuperscript{69} On-line trial version of WISARD can be explored from \url{http://www.ecobilan.com/uk_wisard.php}, accessed on May 10, 2007.
unprofitable, then the disassembly into parts follows. Working parts can be resold while the rest would be processed.

Practically, electrical and electronic products contain sets of several basic building blocks, which include heavy metals (mercury, lead, cadmium, chromium) and halogenated substances (chlorofluorocarbons – CFCs, polychlorinated biphenyls – PCBs, polyvinyl chloride – PCVs, brominated flame retardants, etc.) as well as asbestos and arsenic\(^{71}\). These all are potentially hazardous and should be removed and treated accordingly. The rest of the separated material can be sorted into discrete streams (for example precious metal, other metal, plastic, wood, circuit boards, disk drives, motors, etc.) and further reprocessed, if they have any potential value. In the lack of potential recycling value, the waste ends up in the waste for energy recovery or disposal facility. The remainder will undergo shredding, granulating, balling and washing before identification and separation. After cleaning, the result is a high stream of materials, which can be used again.

Enhancing the recycling can decrease the extent of WEEE disposal, however without a proper pre-treatment it might actually add to the environmental pollution. When recycling metal substances of WEEE, containing halogenated plastics, both dioxins and furans can be generated. Their risk to the environment is increased by the lack of proper

---

identification of plastics containing flame retardants\textsuperscript{72}. Recyclers do not process plastic from WEEE. Currently, very little PVC waste and WEEE is recycled\textsuperscript{73}. Due to the range of products and materials involved in the WEEE, the recycling of end-of-life equipment would require the availability of a wide range of recycling processes.

The most common items recycled/refurbished in the UK are the Large Household Appliances (LHA), which include fridges, freezers, washing machines, driers and cookers\textsuperscript{74}. According to the DTI\textsuperscript{75}, 75 per cent of the discarded LHA items are currently collected, from which some can be refurbished and sold on the second hand market. In addition, small household appliances, such as like vacuum cleaners or irons are also involved in the recycling. About 60 – 80 per cent of the total collected appliances will actually be recycled.

The second most common group currently collected and recycled in the UK is the IT and Telecommunication equipment. The waste from IT equipment arises mainly from commercial companies who now organize take-back through commercial schemes. For mobile phones, a nationwide scheme, called Foneback has been launched, offering “end-to-end solution for the reuse and recycling of mobile phones and accessories”\textsuperscript{76}.

\textsuperscript{73} Fezsty, K., "An economic appraisal of collection systems for waste electrical and electronic equipment (WEEE)", Thesis (Ph.D.), Glasgow Caledonian University, May 2003.
\textsuperscript{74} Ibid.
Additionally, charity organisations, e.g. Oxfam, are collecting old handsets to generate revenue to support work with people all over the world.\(^{77}\)

The recycling of Consumer Appliances, especially of cathode ray tubes (CRT’s), is still in the very early stages. However, as computer monitors and televisions can now only be disposed in hazardous landfill sites due to their material content, it is anticipated that this will make CRT recycling economically more feasible.\(^{78}\)

### 3.4.2. WEEE Incineration

Incineration is claimed to be the least environmentally friendly approach within the sustainable waste treatment framework (landfilling in such case should not be considered as a sustainable practice for dealing with waste at all). It is found controversial to place incineration on the same level as reuse and recycling.\(^{79}\)

The negative aspect of the incineration of WEEE is associated with air emissions and the high concentration of metals in the sludge, gas and filter cake. Negative impact that occur during the incineration of WEEE and its components that contain heavy metals like cadmium, lead, brom, chromium, mercury, the halogens etc is widely acknowledged.\(^{80}\)

---


besides the extremely toxic dioxins and furans. Increasing content of plastic fraction in the electrical and electronic appliances also adds to the problem.\(^{81}\)

According to Morley “waste incineration processes [in the UK] are currently in a period of transition from integrated pollution control to the pollution prevention and control requirements of the Pollution Prevention and Control Act 1999 and the Waste Incineration Directive. These impose new, tighter, requirements for the monitoring and control of emissions from waste incinerators.”\(^{82}\)

Industry Council for Electronic Recycling (ICER) concluded that only a small amount, about 5 per cent, of all waste is incinerated in the UK.\(^{83}\) This includes an insignificant amount of WEEE, involving mainly small appliances, as part of the general waste. However, not every WEEE can be incinerated. For example, PVC, which is widely used in electrical and electronic industry, is not suitable for incineration.\(^{84}\)

### 3.4.3. WEEE Landfilling

Driven by the conventional mindset, industry still looks for the cheapest solution. So far landfilling still represents the cheapest solution in many EU member states.\(^{85}\) Thus,

---

according to Tange and Drohman over 90% of the waste stream, including electrical and electronic equipment as well, is landfilled without any pretreatment\textsuperscript{86}. However landfilling is an acknowledged least preferred option when dealing with waste. Negative environmental impacts take place not only when landfill site is uncontrolled, but also when it cannot fulfill environmentally sound technical standards, leading to considerable input of hazardous materials into the disposal routes.

One of the main problems of landfilling, as already been mentioned in this paper, is leaching out of such substances as heavy metals or halogens into the soil and groundwater and locking away precious metal when WEEE is damaged or destroyed. Another area of concern is proven to be connected with high level of scientific uncertainty about the processes and interactions of WEEE components while landfilled.

CHAPTER FOUR: TRANSPOSITION OF EC WEEE DIRECTIVE OBLIGATIONS INTO THE UK LEGAL SYSTEM

4.1. Introduction

One of the goals of the EU environmental legislation is acknowledged as an improvement of the waste disposal and recycling, especially of such waste streams as municipal waste, packaging, cars and electric and electronic equipment\(^87\). The perception of waste management has changed, high standards have been set and industry now seeks to make profit from waste “instead of dumping it”. It is estimated that more than 1.3 billion tonnes of waste are generated in the EU per year\(^88\). Surprisingly enough, but the rate with which waste generation increases proves to be equal to the economic growth rate\(^89\). EU takes all possible measures to at least stabilize its levels of waste generation.

4.2. EC WEEE Directive – Overview

WEEE Directive sets the objectives as:

- To prevent WEEE;
- To increase reuse, recycling, and other forms of recovery;
- To minimize the risk and impact on the environment from all operations involved in the lifecycle and treatment of electrical and electronic equipment at the end-of-life

---


**WEEE Directive Definitions**

The Directive identifies waste prevention as a first priority. Moreover, waste prevention; source reduction and different types of waste treatment also improve resource efficiency, while maintaining the same level of industrial profitability\(^9^0\).

It should be mentioned that according to the European new waste strategy waste recovery is a broad term used to represent the process by which waste is converted either into a usable form or energy is derived out of the waste\(^9^1\). The EU framework directive on waste defines that term “recovery” shall mean any of the operations provided for in Annex II, B\(^9^2\), which are presented in the following Table 1.

**Table 1. Annex IIB of the Waste Framework Directive, Recovery operations.**

<table>
<thead>
<tr>
<th>R1</th>
<th>Use principally as a fuel or other means to generate energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>Solvent reclamation/regeneration</td>
</tr>
<tr>
<td>R3</td>
<td>Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)</td>
</tr>
<tr>
<td>R4</td>
<td>Recycling/reclamation of metals and metal compounds</td>
</tr>
<tr>
<td>R5</td>
<td>Recycling/reclamation of other inorganic materials</td>
</tr>
<tr>
<td>R6</td>
<td>Regeneration of acids or bases</td>
</tr>
<tr>
<td>R7</td>
<td>Recovery of components used for pollution abatement</td>
</tr>
<tr>
<td>R8</td>
<td>Recovery of components from catalysts</td>
</tr>
<tr>
<td>R9</td>
<td>Oil re-refining or other reuses of oil</td>
</tr>
<tr>
<td>R10</td>
<td>Land treatment resulting in benefit to agriculture or ecological improvement</td>
</tr>
<tr>
<td>R11</td>
<td>Use of wastes obtained from any of the operations numbered R 1 to R 10</td>
</tr>
<tr>
<td>R12</td>
<td>Exchange of wastes for submission to any of the operations numbered R 1 to R 11</td>
</tr>
<tr>
<td>R13</td>
<td>Storage of wastes pending any of the operations numbered R 1 to R 12 (excluding temporary storage, pending collection, on the site where it is produced)</td>
</tr>
</tbody>
</table>


Only two forms of waste recovery from the Table 1 - reuse and recycling - are specifically mentioned in the Article 1 of WEEE directive, however “other forms of recovery” can be understood as reclamation, incineration (or energy recovery), and even exchange of waste.

There are concerns associated with the definitions used in the WEEE Directive. Thus, definition of the waste after treatment appears to be rather inadequate. Recyclers, retailers and manufacturers throughout the whole product’s life cycle stages require clarification of the waste definition boundaries, as what is waste for a retailer can be a product for a manufacturer. According to that, electrical and electronic equipment and/or its parts could be transformed from waste to useful items or raw materials and then resold after processing. Such transformation is not defined in the present directive. This makes a link with the fact that the Directive requires manufacturers to guarantee the participation in an appropriate scheme for the financing of the WEEE management, which would cover at least the collection, treatment, recovery and environmentally sound disposal. However, if an item would enter the second-hand market, obviously the new, so-called, “producer” would also have to subsidize the same waste management (collection, treatment, recovery and environmentally sound disposal), which would mean double financing.

Article 3 further expands the WEEE Directive definitions. First, “Electrical and Electronic Equipment” (EEE) is interpreted as all equipment depending on electric currents or electromagnetic fields for their operation. Also mentioned is that the

---

equipment presented in the categories of the WEEE Directive may not exceed 1000 Volt for alternating current and 1500 Volt for direct current.

Under the definition “Waste Electrical and Electronic Equipment” (WEEE) all components, such as housings, electric motors, circuit boards, transistors, capacitors, screens, keyboards etc are construed. This definition applies only for those components, which are part of the product at the time of the discarding. Next, definitions, such as “prevention”, “treatment”, “disposal”, “recovery”, “recycling” (excluding energy recovery) and “re-use” are mentioned and expounded.

"Producer" is interpreted as anyone who manufactures EEE under his own brand, sells products under own brand but manufactured by the others, resells (including distance and electronic selling) or imports EEE. “Guide to the implementation of directives based on the New Approach and the Global Approach” issued by European Commission identifies “sell” as “putting on the market”. There are no exemptions whatsoever for SMEs (Small and medium enterprises) under the WEEE Directive, and hence the Directive and its requirements should apply to all businesses regardless of the size. However the UK Government is “working to ensure that any costs to SMEs are not disproportionate”.

Then the definition of “waste electrical and electronic equipment from private households” is presented as WEEE from private households as well as from commercial,
industrial, institutional and other sources yielding WEEE similar to those from private households.

**The Scope of the WEEE Directive**

The Scope of the directive is presented in the Article 2 of the Directive. Product categories and examples of electrical and electronic equipment are specified and listed in the corresponding Annex, which, as intended, would be subject to a continuing update. For majority of the equipment, the decision on whether it is included within the scope should be straightforward. However, especially in industrial sectors, there are a number of products, where there may be areas of doubt and uncertainty⁹⁶.

European Commission’s guidance⁹⁷ names different types of WEEE products and equipment, which might be a matter of controversy. Such as for example equipment, which is part of another type of equipment, is not considered as finished product⁹⁸. However, only the courts can give final decision on the matter. That is why DTI guidance notes on WEEE regulations propose a specific “decision tree” to be used in scooping, but at they same time it strongly encourages producers seek independent legal advice in scooping activities.

---

⁹⁸ Ibid.
**WEEE Collections**

The Directive encourages such Product design and EEE production, which takes into account and facilitates dismantling, recovery and in particular the reuse and recycling of WEEE or their component materials (see Article 4). Moreover, Member States shall also minimize the disposal of WEEE as unsorted municipal waste and promote high levels of separate collection. Collection systems should be established to ensure the return of WEEE from private households free of charge. Also, systems ensuring the availability and accessibility of the collection facilities for final holders and distributors free of charge should be introduced. Distributors should offer “new for old” one-to-one take-back services for free. Producers are allowed to set up and operate take-back systems for the WEEE from private households on collective and/or individual basis. According to the WEEE Directive producers are envisaged to be individually responsible for “new” electronic and electrical equipment; however, collective arrangements are still allowed for “historic” waste/equipment.

The collected WEEE should be transported to Authorized Treatment Facilities (ATFs) afterwards and the transport and collection should be carried out in such a way that reuse and recycling would be optimised. Thus, according to the UK Environment Agency WEEE operator needs to hold a permit (Waste Management Licence) issued by the Agency. The operator should be in posses of appropriate site planning permission and

---

necessary equipment to ensure that WEEE is treated “to the required standard and in a way that does not cause harm to the environment, workers or people living nearby”.

According to the Directive, the collection target should be at least 4kg of WEEE per inhabitant per year, which, however was determined in the absence of precise data on the annual rise of WEEE. Results achieved at the national take-back systems that are currently in place in some of the European countries suggest that the range of WEEE collections varies from 4.7 to 9.4 kg per inhabitant per year\textsuperscript{101}. This target of 4 kg is expected to be re-examined in December 2008.

**WEEE Treatment**

For the purposes of the Directive term “treatment” is defined as “any activity carried out on WEEE after it has been handed over to a facility for de-pollution, disassembly, shredding, recovery or preparation for disposal, and any other operation carried out for the recovery or disposal or both of WEEE”\textsuperscript{102}. It is emphasized that producers may set up an individual or collective system for this. Minimum treatment shall include the removal of all fluids and selective treatments in accordance with the directive’s Annex II. The importance of subjecting WEEE to minimum standards for those carrying out recycling and treatment operations is described in recital 17 of the WEEE Directive as


“the most effective way of ensuring compliance with the chosen level of protection”\textsuperscript{103}. Next, the requirements for issuing permissions for the treatment operations are listed along with instructions on their annual inspections by the competent authorities. The inspection should be carried out on the types and quantities of the treated WEEE as well as on the technical and safety requirements of the operation. The technical requirement for this waste should be in compliance with Annex III of the directive.

Article 6 requires WEEE treatment to be carried out using “best available treatment, recovery and recycling techniques” (BATRRT). BATRRT stands for the extension of the principles of BAT to systems that provide for the recovery, recycling and treatment (RRT) of WEEE\textsuperscript{104}. However, on practice BAT principle should imply that “the cost of applying techniques is not excessive in relation to the environmental protection they provide”, meaning “best available techniques not entailing excessive costs” (BATNEEC). According to Defra Guidance\textsuperscript{105} BAT means “the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole”.

\begin{footnotesize}


\textsuperscript{105} Ibid.
\end{footnotesize}
Recovery Standards for Different Categories of WEEE

WEEE Recovery standards are laid down in Article 7. The objectives of the Directive can be met by systems of separate collection for WEEE and recovery systems set up by the producers. By 1 January 2006, all Member States shall take measures to ensure that quotas are met for the separate collection of WEEE. These are summarized in the following Table 2. The targets will be re-examined in December 2008 and new targets will be added for the products of Category 8, Medical equipment, which has for the present been left out of the list. The technical progress achieved in reuse, recovery and recycling along with experiences gained by the member states and the industry will also be taken into account to gain the maximum environmental benefit, such as resource efficiency etc.\(^{106}\).

Table 2. Recovery targets laid down in the WEEE Directive

<table>
<thead>
<tr>
<th>Category 1 – Large household appliances</th>
<th>Average weight rates of the appliances for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 10 – Autodispensers</td>
<td>Recovery: 80%</td>
</tr>
<tr>
<td>Category 2 – Small household appliances</td>
<td></td>
</tr>
<tr>
<td>Category 5 – Lighting equipment</td>
<td></td>
</tr>
<tr>
<td>Category 6 – Electrical and electronic tools</td>
<td></td>
</tr>
<tr>
<td>Category 7 – Toys</td>
<td></td>
</tr>
<tr>
<td>Category 9 – Monitoring and control instruments</td>
<td></td>
</tr>
<tr>
<td>Category 4 – Consumer equipment</td>
<td></td>
</tr>
<tr>
<td>Category 5 – IT and Telecommunication equipment</td>
<td></td>
</tr>
</tbody>
</table>

Producers are obliged to finance collection, treatment, recovery as well as the environmentally sound disposal of WEEE from private households deposited at the collection facilities by August 2005 (“historical waste”). For products put on the market after this date, producers will be responsible for financing operations related to their own

products either individually or by joining a collective scheme. Furthermore, they will have to guarantee that at the introduction of a new product, they will provide the finance for the end-of-life management of WEEE. The costs for collection, treatment and disposal will be allowed to be shown on the label of a new product for only a transitional 8-year period (10 years for Category 1). However, after this time interval, the cost should not be shown separately any more but included in the price of the product. Financing the management of “historical waste” should be shared between producers existing on the market at the time when such costs occur. Financing of WEEE from other than private households is described as being financed by the producers, similarly to the historical waste. The directive alternatively suggests that costs can be covered by other agreements between the producer and the commercial/industrial user.

**Provision of Information**

The Directive requires that consumers should be informed about the available return and collection systems and also the importance of participating in the recovery and disposal of WEEE (see Article 10). To add to this the fact, that producers are obliged to appropriately mark all EEE put on the market (except for “historical”) as well as provide information for treatment facilities in order to enable the identification of the different components and materials in the EEE. Prevention of the negative impacts on the health and safety of the workers and the environment should be a priority.
In conclusion the Directive focuses on the reporting of the information, which should be made on an annual basis on the quantities and also on the categories of EEE put on the market and WEEE collected, reused, recycled and recovered.

**Annexes to the Directive**

Furthermore, the Categories of Electrical and Electronic Equipment are covered in the Annexes, along with an Indicative list of products, which fall under the categories. Selective treatment for materials and components of Waste Electrical and Electronic Equipment, Technical requirements and Symbols for the marketing of Electrical and Electronic Equipment are also listed here.

**4.3. Positive Implications from the Implementation**

The WEEE Directive will bring not only “direct environmental benefits” and benefits to human and animal health, but it will boost resource productivity and will lead to sustainable development of the country itself\(^{107}\). Consultations conducted by DTI also suggest that there may be “knock-on” benefits in terms of raising awareness of other forms of waste amongst consumers and other stakeholders in the UK, and in raising awareness of environmental issues more widely amongst a range of UK stakeholders\(^{108}\).


Reduction in resource use and negative externalities from WEEE disposal

Landfilling is the most common type of WEEE treatment in the UK. DTI with the reference to Materials Recycling Weekly is quoting average cost of gate fee to be in the region of 25 pounds per tonne; costs of municipal solid waste collection from civic amenity sites - in region of 10 pounds per tonne; refrigerators and freezers - 30 pounds per tonne\textsuperscript{109}.

The Directive requires all non-household to be separately collected for reuse, recycling or recovering together with the 4kg per head target set for the household waste. Increase in reuse and recovering should lead to the reduction in new raw materials usage according to the idea of the WEEE Directive; as well as recycling and other sustainable waste treatment techniques should help to minimize negative environmental externalities.

Contribution to sustainable development and resource productivity

The reuse, recycling and recovery of materials from WEEE will contribute positively to the UK Government’s policies on sustainable development and resource productivity. Greater levels of limited physical resources will be available for use because they will not be disposed of in landfill, and there will be less need to mine or produce primary/virgin materials. In addition, there should be reduced uses of energy use from recycling and re-using materials compared to the production of primary materials.

Reduction in hazardous waste disposal

Understanding an elevated content of the hazardous materials in electronic and electrical waste in comparison to generic municipal solid waste, it becomes obvious that negative externality from WEEE are greater as well. In this context, the announced increases in the Landfill Tax “more accurately reflect the externalities from landfilling WEEE specifically”\textsuperscript{110}. The DTI commissioned PriceWaterhouseCoopers (PWC)\textsuperscript{111} to update a 1999 report produced by Ecobalance UK\textsuperscript{112}, which compared the “current UK situation with what could occur following WEEE implementation in the UK”, using a number of environmental indicators. The Report considered that restrictions set up in the WEEE Directive should mitigate the negative effects in different areas, such as greenhouse effect and decline in water eutrophication. Additionally the overall change in the patterns of WEEE handling should lead to mitigation of the ozone layer depletion as well as depletion of non-renewable resources. Particularly in terms of hazardous waste, the Report says “…the amount of hazardous waste generated by the WEEE directive scenario does not appear to be significant”.

Reduction in energy use and carbon and CO2 emissions

As previously mentioned, the need for new materials will be reduced, allowing positive contributions to energy use reductions, as well as WEEE use for energy recovery should


\textsuperscript{111} Ecobalance UK has been acquired by PWC “Environmental Life Cycle Assessment and Financial Life Cycle Analysis of the WEEE Directive and its implications for the UK” – Update of the WEEE Directive Study, PWC, 2002

\textsuperscript{112} Life cycle assessment and life cycle financial analysis of the proposal for a directive on waste from electrical and electronic equipment, Ecobalance UK, 1999.
contribute to reductions in CO2 emissions. DTI quotes PWC Report, which suggests “a significant reduction in greenhouse gas emissions from WEEE Regulations compared to the current UK situation.” However it should be mentioned that the UK is now operating from a lower baseline than estimated by PWC, because since the study was published the amount of baseline emissions changed due to the UK ODS Regulations enactment, which requires separate collection and pre-treatment of all refrigeration. ERM in its report to Defra estimates the decrease in emissions of carbon per tonne of mixed WEEE up to 0.35 tonnes when WEEE regulations come into force.

**Revenue from metals recycled in WEEE**

The increased separate collection of WEEE in the UK is likely to lead to additional metals being available for recycling. However, they are not expected to be of “sufficient volume and have a material impact on the price of secondary metals.”

In addition to abovementioned positive effects of the new WEEE Directive regime, DTI partial regulatory assessment identifies “positive “spillovers” to other forms of waste and

---

113 The Environmental benefits of recycling, Waste and Resources Action Programme (WRAP), May 2006.
environmental issues”, such as awareness raising in relation to other forms of household and business waste, such as, for example, packaging waste and spent batteries\textsuperscript{117}.

4.4. UK Implementation of WEEE Directive

4.4.1. UK Governmental Response – DTI and Defra Approach

Department of Environment, Food and Rural Affairs

In March 2004 the UK Department for Environment, Food and Rural Affairs (DEFRA) commissioned AEA Technology to produce a Report on WEEE and Hazardous Waste\textsuperscript{118}. The main objectives of the report were to “identify the products and components of present and historic waste from electrical and electronic equipment (WEEE) that are hazardous as well as WEEE components that display hazardous properties above the threshold criteria as laid out in the Hazardous Waste Directive (HWD) and the Hazardous Waste List (HWL), and secondly to determine what renders those products depolluted and non-hazardous”\textsuperscript{119}. According to the Report extensive literature review to determined the range of typical components found in electrical and electronic equipment. The study covered most common types of WEEE (representing greater than 80% of this waste stream). However there still remains a “significant proportion of WEEE that falls in the “unknown” area”. The report also found that some other substances not specified in Annex II of the WEEE Directive may be hazardous, such as plastics and rubbers


\textsuperscript{119} Ibid.
containing phthalate plasticizers or lead stabilisers, lithium batteries, and components containing mineral wools that come under the classification as a category 3 carcinogen.

More recently AEA Technology conducted Part 2 WEEE and Hazardous Waste Report\textsuperscript{120}. This report acknowledges one of the main findings of Part 1 report reciting that a significant proportion of WEEE falls into the “unknown area” and “seeks clarification of these unknowns”. The second report represents guidance for local authorities, treatment facilities, recyclers and other interested parties in identifying WEEE and hazardous WEEE. This report presents initially the results from both the physical dismantling trials and the subsequent chemical analyses that were conducted; 157 items of WEEE that represent “the unknowns” were sourced mainly from civic amenity cites and further examined in this study.

This document provides guidance on the WEEE Licensing Regulations, as well as guidance on the treatment, recycling and recovery of waste electrical and electronic equipment (WEEE) at an authorised treatment facility (ATF). The guidance is an official interpretation of the treatment, recycling and recovery standards set by the WEEE Directive as seen by Defra, Welsh Assembly Government and the Scottish Executive.

Starting from the year 2003 DTI was working on the implementation of the WEEE directive into the UK domestic law. During with work it have conducted a number of surveys and issued different reports.

One of the first reports was a Study into European WEEE Schemes conducted by Future Energy Solutions for DTI to support the implementation of the WEEE directive in the UK. The study represents a comparative overview of the structure, operation and performance of the several EU waste collection and treatment schemes. Six countries were analysed: Belgium (Recupel), Denmark (Municipal Targeted Tax), Netherlands (ICT Milieu, NVMP,) Norway (El Retur), Sweden (El Kretsen) and Switzerland (SWICO). The authors of the survey acknowledge the difference in ownership (some of the schemes are non-profit companies organized by the industries themselves, others are owned by governments or municipalities), huge variations in the volumes of waste collected and treated as it depends not only on pursued policies and current practices but also on the overall amount of population in the given country, costs and benefits from the collection and treatment processes, etc. It is as well acknowledged that all schemes established their own financial and administrative systems from scratch.

In the same year DTI issued a Discussion paper on implementation of WEEE and RoHS Directives followed by Responses to discussion paper. The given paper and the

122 Ibid.
123 Discussion Paper on implementation of Directives 2002/96/EC on waste electrical and electronic equipment (WEEE) and 2002/95/EC on restriction of the use of certain hazardous substances in electrical
responses to it emphasized that implementation of WEEE Directive will reduce risks to human health and environment through the proper treatment of waste and a reduction in hazardous substances. It was found that with WEEE directive regulations at hand a “reduction in air pollution, including CO2 and ozone depleting substances, and water toxicity by more than 50% when compared to existing practice” is achievable. In particular, WEEE Directive was claimed to assist in diverting up to 340 thousand tonnes of waste from landfill; to add to this benefits expected through the conservation of raw materials and of energy resources.

Assessment of Responses to the Second Consultation Document: WEEE and RoHS Directives\textsuperscript{125} represents a review and assessment of stakeholder consultation responses to the Government Consultation Document on the WEEE and RoHS Directives (November 2003), which included total of 20 questions in relation to the implementation proposals for the WEEE Directive. The stakeholders presented can be divided into several groups such as local authorities, trade associations, consultants, waste management authorities, manufacturers and some others. A significant number of respondents identified ‘gray areas’ and uncertainties that need to be resolved and asked for further clarification and guidance. Concerns were also raised about inclusion or exclusion of different products. All responses to the WEEE and RoHS consultations were summarized in the Executive

summary for the second and third consultations in April and November 2004 respectively\textsuperscript{126, 127}.

A number of the DTI reports were specifically devoted to either full or partial regulatory impact assessment of the specific WEEE topics, such as appraisal of proposed WEEE fees\textsuperscript{128}, as well as anticipated potential costs and benefits from different combinations of alternative collection and treatment schemes and mechanisms\textsuperscript{129}.

In 2003 the DTI commissioned Perchards to produce a series of reports on existing WEEE-related measures and the type of transposition plans that were developing in other member states\textsuperscript{130}. The last report in this series “Transposition of WEEE and RoHS Directives in the other EU Member States” dated 2005 represents an overview of the current WEEE management systems present in all the EU Member states.

Final policy paper produced by DTI on the topic of proposed WEEE implementation regulations is “WEEE Directive: conclusions and implementation review”\textsuperscript{131}, together

\begin{footnotesize}
\begin{enumerate}
\end{enumerate}
\end{footnotesize}
with supplementary paper\textsuperscript{132}, issued in 2006. This implementation review was followed by the updated regulatory impact assessment research conducted in 2006\textsuperscript{133} as well. The official consultations were combined with informal stakeholder consultations as a part of the assessment.

The two most recent surveys published by the DTI are the Code of Practice for collection of waste electrical and electronic equipment from Designated collection facilities\textsuperscript{134} and a study “WEEE Regulations: Government guidance notes”\textsuperscript{135}. The Code “should form a basis and starting point” for cooperation between the stakeholders: producers, local authorities and independent designated collection facilities owners. In its turn Guidance Notes cover producers and distributors obligations in relation to electrical and electronic equipment introduced and circulating on the UK market.

\subsection*{4.4.2. Risk Assessment}

As already discussed, the major impact on environment, human and animal health from WEEE is the potential damage caused by WEEE when it is discarded and disposed of subsequently\textsuperscript{136}.

A significant tonnage of WEEE is understood to be separately collected and reused or recycled in the UK currently. However, even in such cases, treatment prior to recycling does not take place generally. This means that the residues following recycling should be hazardous when disposed of. The exception to this is refrigeration equipment containing Ozone Depleting Substances (ODS), as ODS are required to be removed under the separate UK ODS Regulations prior to recovery or disposal. Also, from 16 July 2005, WEEE which is separately collected, and which contains cathode ray tubes (CRTs) and mercury in gas discharge lamps needs to be pre-treated prior to disposal under the Waste Acceptance Criteria (WAC) of the Landfill Directive\textsuperscript{137}.

There is also the issue of the vast number of EEE items estimated to be discarded in the UK but not separately collected currently. As these will be co-disposed of with other forms of waste they will neither be pre-treated prior to disposal nor recycled or recovered to any significant extent, if at all\textsuperscript{138}. Some of this WEEE could also be hazardous when it is disposed.

The Commission’s Explanatory Memorandum (EM) to the WEEE Directive\textsuperscript{139} estimated that in 1998, 6 million tonnes of WEEE was generated by the member states of the European Union. The EM also said that the volume of WEEE is expected to increase by 3-5 per cent per annum in the future across member States.

\textsuperscript{137} This also applies to ODS containing refrigeration equipment. DTI, EC Landfill Directive.
The EM explains that EEE contains a range of materials and substances of which “…the most environmentally problematic…are heavy metals, such as mercury, lead, cadmium and chromium, halogenated substances, such as chlorofluorocarbons (CFCs), polychlorinated biphenyls (PCBs), polyvinyl chloride (PVC) and brominated flame retardants as well as asbestos and arsenic”. It also says that “…as more than 90 per cent of WEEE is landfilled, incinerated or recovered without any pretreatment, a large proportion of various pollutants found in the municipal waste stream comes from WEEE” and subsequently “…the environmental risks associated with the waste stream are not properly dealt with by current waste management practice”\textsuperscript{140}.

Implementation of the WEEE Directive in the UK should reduce the risks of harm to the environment, human and animal health from WEEE. Though the pathways through which WEEE can produce harm are complex, and make precise risk assessment difficult, the risks of harm from WEEE do exist. The Commission’s EM to the WEEE Directive and a report for the Commission, Heavy Metals in Waste\textsuperscript{141}, in 2002, outline the risks from a range of materials and substances, some of which have been, or are used in the production of EEE. These include lead, mercury, cadmium and chromium.

The pre-treatment of WEEE prior to recycling or disposal, as a consequence of the implementation of WEEE directive, will reduce the risks of damage from any hazardous substances in WEEE. In addition, increased reuse, recycling and recovery of WEEE

\textsuperscript{140} Ibid.
should contribute to tackling concerns surrounding resource productivity, and risks to sustainable development, in the UK and in this content is consistent with the UK Government’s sustainable consumption and production agenda\textsuperscript{142}.

4.4.3. WEEE Directive Implementation Options

The UK, like a number of other Member States, has found the complex and wide-ranging nature of the WEEE Directive challenging\textsuperscript{143} and delayed its implementation. According to DTI the delay aimed for the establishment of “a robust system for WEEE” that would work not only for a short term\textsuperscript{144}.

DTI has considered a number of options by which to implement the WEEE Directive. The matter of the main concern was how to transfer the waste from consumers and end-users to producers, who are obliged to deal with it. Should each individual producer physically handle WEEE, or should he be able to discharge an obligation by financial means? Still the Directive allows certain level of flexibility in ways of fulfilling its requirements. In the case of the UK an emphasis was made on costs in relation to the treatment and recycling of WEEE. The following paragraphs discuss the main options envisaged by DTI. They are not mutually exclusive, and should be combined in various ways to provide “a package for implementation”\textsuperscript{145}.

\textsuperscript{142} Taking it on – developing UK sustainable development strategy together, Downloaded from www.sustainable-development.gov.uk, accessed on May 8, 2007.
\textsuperscript{143} Ibid.
**Option A.**

**Mandatory in-store takeback of household WEEE by each individual retailer.**

According to the information provided to DTI by the British Retail Consortium such system would be cost-effective in achieving the separate collection target for household WEEE required by the Directive. These cost estimates have ranged at various times from between £200 million to £500 million per annum\(^\text{146}\). Imposing mandatory in-store takeback would likely add significantly to the costs of implementing the WEEE Directive in the UK.

**Option B.**

**Physical collection of household WEEE by each individual producer.**

National Clearing House (NCH) was envisaged as the best solution for the implementation of the Directive in the UK\(^\text{147}\). It supposed to allocate the responsibility on producer-by-producer basis at the time of WEEE arising. The exact operational costs are unknown but anticipated as millions of pounds. Positive experience of NCH in Germany proved “relatively cost-effective means of achieving the treatment requirements and recovery targets”.

**Option C.**

**Physical allocation system established by the UK Government**

---

\(^{146}\) Ibid.

Physical collection trial system was established by DTI for a number of producers. The proposed system was similar to the Landfill Allowance Trading Scheme (LATS) and enabled producers to trade evidence of physically collected WEEE\textsuperscript{148}. Estimated cost of the establishment of a LATS type was calculated in the region of £250,000 (as one-off cost).

**Option D.**

**Producer obligation by total weight of household WEEE or by type of household WEEE arising.**

According to the Directive Member States can determine producer’s financial obligations as a whole, in tonnage terms. Despite that the UK regulations propose the differentiation of financial obligations regarding the type of EEE produced. This would not lead to any substantial increase in treatment and recycling costs but “should provide a more equitable and fairer distribution of costs between producers, given that producers will only be responsible for WEEE which is of similar type to EEE they produce”\textsuperscript{149}.

**Option E.**

**Introducing individual producer responsibility for new EEE put on the UK market.**

Individual producer responsibility is envisaged as the “purest form of the producer responsibility”, as it shows a clear intention of the producer to design products for recycling\textsuperscript{150}. However, DTI states “the challenges of introducing IPR for EEE in the UK

---


\textsuperscript{149} Ibid.

\textsuperscript{150} The Government has implemented the End-of-Life Vehicles Directive in the UK via IPR, i.e. vehicle manufacturers being responsible for their own brand of vehicles when they reach the end of their life.
currently are formidable”\textsuperscript{151}. However to make the system cost-effective special infrastructure should be in place to ensure separate collection, which is currently missing.

**Option F.**

**Making producer compliance scheme membership compulsory for each producer.**

Despite DTI’s proposal to make producer compliance scheme membership optional, the Environment agency suggests that compulsory producer registration will be more effective, as the total number of separate applications decreases.

**Option G.**

**Requiring exceptional arrangements for Non-Household WEEE.**

According to the proposed requirement producers should incorporate WEEE obligations into their business practices\textsuperscript{152}. This should help to meet the Directive’s targets at least cost to producers of non-household WEEE.

**Option H.**

**Extending the scope of the WEEE Directive in the UK.**

The Directive provides the opportunity to broaden the range of equipment and products in comparison to those specifically mentioned. However this will impose additional burden onto the UK business as a member of European Single Market.


Option I.

Introducing a mandatory “visible fee” for WEEE.

According to DTI a “visible fee” is an “explicit charge placed on new equipment to finance any costs from treating and recycling old equipment”. However this will increase regulation costs, such as enforcement costs, monitoring costs, administrative costs, etc. Member States, which have established a central body for waste collection and treatment generally would implement “visible fees”. For example Auto Recycling Nederland (ARN) do this for end-of-life vehicles in the Netherlands.

Not all of the presented options have been implemented in the UK according to The Waste Electrical and Electronic Equipment Regulations 2006\(^{153}\) so far. For example NCH option despite being proposed by producer community is still under consideration. Sustainable Electronic Waste Policy Forum (SEWPF) proposed a model of NCH where WEEE should be collected from a designated collection facility on a scheduled basis\(^ {154}\). Main advantages of this single coordinating body are envisaged to be fairness towards producers as well as competitiveness between the producers in relation to organisation of treatment and recycling of WEEE\(^ {155}\).


4.4.4. Costs and Benefits of Transposition of the WEEE Directive

As previously mentioned, certain percent of WEEE is already been treated according to the requirements set in the Directive. However this is usually true in relation to specific equipment “where there is value to be gained from either re-using components or whole appliances”\textsuperscript{156}, or where such requirement is supported by additional legal regulation.

Transposition costs and benefits will be influenced by the achieved rate of separate collection of WEEE, which cannot be known in advance and is anticipated to vary each year\textsuperscript{157} as technology to treat WEEE develops. To add to this some of the indefinite costs are envisaged to be placed on the producers and retailers, such as registration costs or provision of information costs. Thus any estimates provide only indicative numbers.

Industry Council for Electronic Recycling (ICER) estimates that total household WEEE arising in the UK will be in the region of 1.1 million tonnes in 2007; with a certain percentage of household WEEE arising is amongst the 10 categories of EEE in the WEEE Directive\textsuperscript{158}. DTI indicates that all large household appliances (Category 1 of the WEEE Directive) as well as all CRT monitors, fluorescent tubes, and mobile phones arising as waste are separately collected currently in the UK\textsuperscript{159}. Moreover, Landfill


\textsuperscript{159} Partial regulatory impact assessment on the proposed Environment Agencies fees (WEEE fees) for implementation in the UK of Directive 2002/96/EC of the European Parliament and of the Council on
Directive requires through its Waste Acceptance Criteria (WAC) CRTs and fluorescent tubes to be pre-treated prior to disposal as it is now classified as hazardous under the UK’s Hazardous Waste Regulations. The 2002/2003 Commercial and Industrial Waste Survey of the UK Environment Agency proves around 14 per cent of discarded equipment to be reused\(^{160}\). DTI envisages up to 15 per cent increase in the reuse of household WEEE, and to 20 per cent of non-household appliances\(^{161}\). An outline of a framework to estimate costs and benefits of household WEEE used in the DTI regulatory impact assessment is summarized in Table 3 below.

**Table 3. An Outline Framework to Estimate Costs and Benefits for Household (by DTI)**

<table>
<thead>
<tr>
<th></th>
<th>Benefits</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producers of WEEE</td>
<td>Value from Categories 2-9 metals when discarded and separately collected</td>
<td>Costs of collection, treatment and recovery of Category 1-9 EEE when discarded and separately collected</td>
</tr>
<tr>
<td>Distributors of WEEE</td>
<td>Avoidance of ODS costs for Category 1 EEE, and avoidance of CRT costs for Categories 3 and 4 EEE when collected to delivery</td>
<td>Costs of take-back networks or in-store takeback for WEEE</td>
</tr>
<tr>
<td></td>
<td>Avoidance of disposal costs of non-metals in separately collected Categories 1, 3 and 4 EEE</td>
<td>Loss of value of metals from Categories 1, 3 and 4 EEE when collected on delivery</td>
</tr>
<tr>
<td>Local Authorities</td>
<td>Avoidance of collection and disposal costs of Category 1 EEE when discarded</td>
<td>Costs of provision of information on WEEE</td>
</tr>
<tr>
<td></td>
<td>Avoidance of ODS costs for Category 1 EEE, avoidance of CRT costs for Category 3 and 4 EEE, and avoidance of treatment costs for Category 5 EEE</td>
<td>Loss of value of metals from Category 1 EEE when discarded</td>
</tr>
<tr>
<td></td>
<td>Avoidance of collection and disposal costs of Category 2-9 EEE when discarded</td>
<td>Loss of value of metals from CRTs and fluorescent tubes when discarded</td>
</tr>
<tr>
<td>External Environmental Impacts</td>
<td>Reductions in resource use and externalities from disposal of EEE</td>
<td>Increased transport emissions from increased separate collection of WEEE</td>
</tr>
</tbody>
</table>

---


Reduction in energy use and reduction in carbon emissions from re-use and recycling of secondary materials over primary production
Contributions to sustainable development and resource productivity

As for non-household WEEE, the cost and benefits are anticipated to be fairly similar. However, Local Authorities may be less involved in the collection of non-household WEEE\textsuperscript{162}.

4.4.5. New Mechanisms and Practices Implemented by the Directive

The majority of costs will be born in the areas where the WEEE handling systems would have to be built from scratch. There are essentially three main additional activities to be undertaken by the WEEE Directive that has not been undertaken, or consistently undertaken, in the UK historically\textsuperscript{163}. These are separate collection of WEEE from other forms of waste; WEEE pre-treatment prior to further processing; and reuse, recycling and recovering WEEE materials that “have not been “economic” to recycle or reuse in the past”.

\textit{Separate Collection of WEEE}

The WEEE Directive does not require the separate collection of all WEEE arising within a member State. However, it requires member States to take steps to minimize the disposal of WEEE as unsorted MSW.


\textsuperscript{163} Ibid.
The WEEE Directive sets an explicit minimum target for separate collection of household WEEE arising in a member State of 4 kg per head of population per annum, which means that the UK has to separately collect minimum 240,000 tonnes of WEEE, given that a UK population is around 60 million\textsuperscript{164}. ICER report states that over 1 million tonnes of household WEEE have been discarded in the UK in 2003\textsuperscript{165}. Taking into account 4 per cent annual growth of electronic waste\textsuperscript{166} DTI estimates constant rise in tonnes and units of collected waste up to the year 2017, from 1.1 million tonne in 2007 till 1.63 million tonne in 2017\textsuperscript{167}. Speaking about non-household waste ICER estimates future non-household arising to increase from 0.94 million tonne in 2007 till 1.40 million tonne in 2017\textsuperscript{168}.

DTI worked out two scenarios of possible collection of household WEEE outside of Category 1. Scenario 1 was built on the assumption that WEEE collection in the UK increases to the same rates as in the Netherlands after the introduction of the NVMP system\textsuperscript{169}. The estimates are shown in the following Table 4.

Table 4. Scenario 1 – Separate collection of household WEEE arising

|----------------------|------|-----------|-----------|


\textsuperscript{169} In the Netherlands, The Dutch Association for Domestic Appliances and the Association for Electronics Manufacturers set up a recovery system (NVMP) for white goods and small domestic appliances in January 1999.
The essence of Scenario 2 was that the rates of separate collection would inevitably be fuelled by the behavioral changes forced by the implementation of the WEEE Directive (see Table 5). As can be derived from the comparison of Tables 4 and 5 DTI devote up to 15% increase in collection gains thanks to the behavioral shift in the years 2008-2012, and even up to 30% in 2013-2017.

Table 5. Scenario 2 – Separate collection of household WEEE arisings, behavioral changes embedded

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (large household)</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>2 and 5-9</td>
<td>2%</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>3 (ITC)</td>
<td>25%</td>
<td>55%</td>
<td>70%</td>
</tr>
<tr>
<td>4 (consumer equipment)</td>
<td>39%</td>
<td>58%</td>
<td>70%</td>
</tr>
</tbody>
</table>

According to regulations there are two types of costs in the separate collection costs of household WEEE\(^\text{170}\). First, costs necessary to establish national network of collection facilities; and second, costs of collecting this WEEE from abovementioned facilities and transporting it to authorised treatment facility. According to DTI consultation with the UK industry representatives, one estimate suggest that the costs might be up to 60 pounds

per tonne for large items of WEEE, and up to 120 pounds per tonne for smaller items of WEEE\textsuperscript{171}.

Combining together the two scenarios for separate collection, different types of costs as well as total WEEE arising allowed DTI to estimate the approximate costs for additional separate collection. Thus, the average cost estimate for the year 2017 is 25-36 million pounds, which is nearly a double figure in comparison to the costs estimated for the year 2008\textsuperscript{172}. That is why from one side maintenance costs should decrease, as the system will be put into operation; but from the other side additional costs (e.g. policy costs) would arise.

**Treatment of WEEE**

The WEEE Directive requires all separately collected WEEE to be pre-treated prior to further processing. Implementing this requirement Defra Guidance on Best Available Treatment Recovery and Recycling Techniques (BATRRT) and treatment of Waste Electrical and Electronic Equipment (WEEE) says, “Treatment must, as a minimum, include the removal of all fluids, and the appropriate selective treatments in accordance with Annex II to the Directive”\textsuperscript{173}. Additional attention should be paid to the health and safety issues and removed components storage. The Directive requires hazardous substances to be removed prior to further treatment. Removal in this sense can be defined


\textsuperscript{172} Ibid.

as any mechanical, chemical or manual process that occur at any stage in the treatment process\textsuperscript{174}. Thus type of EEE (or WEEE) will determine the character of the removal activities, e.g. it may be a sequence of different processes taking place at different facilities. DTI suggests that the majority of the WEEE treatment activities are expected to be built on the basis of already existent treatment practices, with the only exception of waste falling under ODS regulations requirements (e.g. refrigerators and freezers).

There is also the issue of how WEEE is actually treated to the requirements of Annex II of the WEEE Directive, particularly, for example, whether it is “fully” treated prior to shredding, or whether a level of treatment can take place post-shredding.

In short term, labor costs may provide the majority of the variable cost element for treating most WEEE given that draining, dismantling and separating equipment will be largely a manual exercise. These costs are likely to vary considerably between EEE products, as some are far more complex then others and thus will take more effort to be treated in accordance with the Directive’s requirements. DTI suggest that these costs could fall over time, and it is likely that technological developments will also lead to reductions in costs over time\textsuperscript{175}.

Thus it should be noted that there is much uncertainty surrounding the costs of treating WEEE to the standards of the Directive. Over the medium-term it is likely that the cost

\textsuperscript{174} Ibid.
per unit of treating WEEE could fall for a number of reasons, including: development and innovation in treatment technologies; fewer refrigerators containing ODS; etc.

**Reuse, recycling and recovery of WEEE**

Producers of electric and electronic equipment are financially responsible for achieving not only reuse and recovery targets, but also for “environmentally sound disposal” WEEE. As already been mentioned there is a “certain level” of reuse and recycling of electronic equipment and its components in the UK currently\(^\text{176}\). However a lot should be done to meet the reuse and recovery targets set up by the WEEE Directive.

DTI assumes that the recovery costs should gradually decrease over time in comparison to the costs that are born nowadays to set up the system. The following estimation is based on the assumption that not only the system will require less costly maintenance, but also the materials, which EEE is made from, will change gradually with least environmentally friendly components phasing out from the industrial circulation. For example, the RoHS Directive bans use of lead, cadmium, mercury, chromium-VI and brominated flame retardants. However for now it is scientifically impossible not to use such substances as lead or cadmium in various EEE components. Reuse and recovery of such metals will allow minimizing their presence in the form of waste as well as will decrease their extraction quantities. Same situation is envisaged with regards to non-metallic materials of WEEE such as plastics, rubbers, glass, foam, etc. Regulatory impact assessment conducted by DTI estimates that actual costs depend not only on type or

\(^{176}\) Ibid.
amount of metals or non-metal components of EEE, but also on the recycling and recovering practices chosen for specific type of WEEE.

**Marking EEE**

Producers are obliged to mark all electronic and electrical equipment introduced into the UK market after 1 April 2007. Thus Article 10 says that users should be given information about the return and collection systems available to them, and their role in contributing to the reuse and recycling of WEEE. Producers should “appropriately” mark EEE, or where “inappropriate”, mark the packaging or paperwork that comes with the equipment, with a crossed out wheeled bin symbol to discourage the co-disposal of WEEE\(^{177}\). There is also a requirement of describing the meaning of the mark itself.

The costs of marking EEE seem to be “not straightforward to estimate”\(^{178}\) as marking can take variety of forms (e.g. plastic mould or sticky label depending on the equipment size) It also remains unclear how many distributors of EEE will be affected by this requirement.

**Information on EEE and registration of WEEE producers**

The Directive in Article 11 sets up a requirement of information provision for each type of equipment put on the market. Every product should be equipped with such reuse and

---


\(^{178}\) Ibid.
treatment information within first year of introduction. Such information should also be available to reuse centers, and treatment and recycling facilities.

The WEEE Directive requires the UK to draw up a register of producers of EEE. Producers must provide to distributors their producer registration number when they sell EEE\textsuperscript{179}. Moreover, Defra proposed establish reporting system to inform of the recycling and recovery targets, achieved by the EEE producers.

\textit{Conclusion}

The numbers given in this section can only be seen as being indicative given the limited amount of data available and the range of assumptions that need to be made to enable estimates to be undertaken. Given estimates are made in relation to current practice in the UK with regard to EEE and WEEE in the UK. But even determining the baseline scenario is not straightforward as there is relatively little information on exactly how all EEE is dealt with when it arises as waste in the UK. Where valued, the costs principally relate to additional costs for the separate collection of WEEE, its treatment, and its recovery to levels not previously achieved in the UK.

The estimates for the cost of treatment are the main drivers of the total costs, but the estimates at the top of the range should be considered as “worst case” estimates, because

it is highly unlikely that all items of WEEE will require treatment by individual “hand-
stripping”\textsuperscript{180}.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion on the WEEE Directive

In conclusion it should be said that the issue of effectiveness is one of the major challenges of any piece of legislation or policy regime. Such piece of legislation as the WEEE Directive should contain certain amount of requisites to become effective and workable. However, practically there is no such thing as “ready-made set of rules” or “necessary requirements”. It varies from situation to situation and from country to country. Thus, every piece of legislation to be effective and have an effective transposition and implementation in national legislation should aim at constant reevaluation and excellence, as reality they ought to reflect is in constant change.

Thus, one of the first concerns is associated with the definitions used in the Directive. For example, definition of the waste after treatment appears to be rather inadequate. Recyclers, retailers and manufacturers throughout the whole product’s life cycle stages require clarification of the waste definition boundaries\textsuperscript{181}, as what is waste for a retailer can be a product for a manufacturer. According to that, electrical and electronic equipment and/or its parts could be transformed from waste to useful items or raw materials and then resold after processing. Such transformation is not defined in the present directive. This makes a link with the fact that the Directive requires manufacturers to guarantee the participation in an appropriate scheme for the financing of the WEEE management, which would cover at least the collection, treatment, recovery and environmentally sound disposal. However, if an item would enter the second-hand

market, obviously the new, so-called, “producer” would also have to subsidize the same waste management (collection, treatment, recovery and environmentally sound disposal), which would mean double financing.

Regarding prevention, the concern is associated with the material suppliers, and in particular the exclusion of materials without risk assessment and without consideration to recycleability. This is especially true when the replacement option of the banded material is environmentally more harmful and less suitable for the health and safety than the original material was. It follows from the above that phased out components should not be recycled and that reusability of such materials is unlikely in new products.

The recovery target applied to the WEEE, which has been “separately collected”, may also exceed the current technical level of possible recovery. Recycles also believe that there is no need for recovery targets as they always claim to maximize the useful output. If governments adopt economic instruments to make waste disposal more expensive, recyclers will increase their productivity. Otherwise, if recyclers offer the only collection point, their data could be taken as 100% of the WEEE that arises and the recovery target could be set based on this information. Fundamentally, the proportion of recycled plastic in a new product could have a positive influence and it could also stimulate the market for the recycling industry.

More importantly, the Directive requires every EU Member State to implement a national law or regulation for the WEEE. However, an internationally common collection and
recycling system is not available. Consequently, it is not possible to apply identical infrastructure for all EU countries due to the geographical differences, the available treatment options and the diverse economical costs.

5.2. Further development of the WEEE Directive regime in the UK

According to DTI the best approach for collecting would be through the recyclers, mainly because their system is already in place\textsuperscript{182}. By using this system, the WEEE could be inspected before entering the landfill site (or incinerator) and all hazardous contents could be removed. Obviously, in the case of the take-back activities or retail outlets, a special storage place would be required alongside a satisfactory customer service and information point at the location of the sale. It would also require quality staff training for inspection and health and safety checks.

The physical collection from private households appears to be less costly and environmentally less damaging through the local authorities collection services. It would be less time-consuming and less energy-demanding too. However, in practice if no better solution could be found for the collection, then at least the collection system should be modified or improved by better public information and lowering the barriers for consumers as suggested by Feszty. Under the above-mentioned circumstances, introducing the parallel collections of several systems could positively influence the final result.

Another problem regards the proposed collection target, which is currently set as 4 kg per inhabitant per year from the private households. It means that in some countries, such as the United Kingdom, less would be required to be recycled than is already processed. It is true, however, that a stricter collection target may discourage technical innovations towards reducing size, weight and usage of recycled materials. The proposed target based on weight or volume is therefore not the best one, because it could alter via further product improvements. Furthermore, high recovery targets “may promote technological innovations but may not lead to significant environmental benefits”\textsuperscript{183}. The current recommendation is that the treatment process should not be specified, because it could set back future technologies.

Lack of data on “historical waste” presents another area of concern for producers and retailers. This information would be indispensable also for all manufactured and exported/imported products in the UK. A proposition regarding this problem is that producers and recyclers should create a system for this wide range of information, which could well influence the recycling processes.

5.3. Recommendations

\textit{Detailed study of WEEE arising on the UK scale}

Different pieces of research and pilot schemes studies have been undertaken within recent several years, however there is still a lack of the UK-level types of studies. With the

transposition of the WEEE directive into the UK legislation there is a growing need for development of national-wide networks (i.e. recycling networks) to make companies involved in WEEE activities strategically linked together. As already been mentioned separate counties and communities conduct such studies, but for the sake of strategic improvements on the national scale an overall study should be undertaken. Separate study should be undertaken on “historical waste”.

**WEEE handling education for local communities**

Understanding the importance of the WEEE handling and treatment, various educational programs, aimed at growing of the communities’ awareness, should be established. The issues that need to be covered include WEEE environmental impacts, types of WEEE and different ways of its treatment, etc. There might be different mechanisms of conducting such educational programs, major retailers or recyclers can be involved as well.

**Feasibility studies of the WEEE treatment facilities**

Feasibility studies of the WEEE treatment facilities are necessary to be undertaken. Such reports should include all aspects of WEEE recycling, “from collection and handling through to markets for the recovered materials”\(^{184}\). Emphasis should be made on economic profitability of the treatment and recycling facilities, as well as logistical implications and feasibility of different collection schemes and activities. The study should reflect the data on different types of WEEE collected in different parts of the UK to produce the most feasible location for certain types of WEEE treatment facilities.

Further research and development of ecodesign and WEEE collection schemes

The UK manufacturers should be encouraged to promote ecodesign to minimize harmful environmental consequences of the WEEE disposal. Different types of tax and incentive schemes can be developed by the government as well as by the business side itself to promote environmental design. Collection schemes that are currently in place should be reviewed and most effective schemes and facilities should be described. Best practices should be established. While doing this the UK can utilize the experience of the other EU Member States.
BIBLIOGRAPHY


Knowles, H., Sheppard, P., Arisings, collection and handling of waste electrical and electronic equipment in Peterborough, prepared by UK CEED for the European


The Environmental benefits of recycling, Waste and Resources Action Programme (WRAP), May 2006.


Waste from Electrical and Electronic Equipment: A South Australian Perspective, University of South Australia, 2000.


